Version 1.0
06/06/21

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Prerequisites

- Have a recent version of Git downloaded and running on your system
  - For Windows, suggest using Git Bash Shell interface
- If you don't already have one, sign up for free GitHub account at

  http://www.github.com

- Workshop doc is in https://github.com/skilldocs/git4
- Labs doc for workshop

https://github.com/skilldocs/git4/blob/main/git4-2-labs.pdf

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Git In Four Weeks
Week 2

Brent Laster

Tech Skills Transformations


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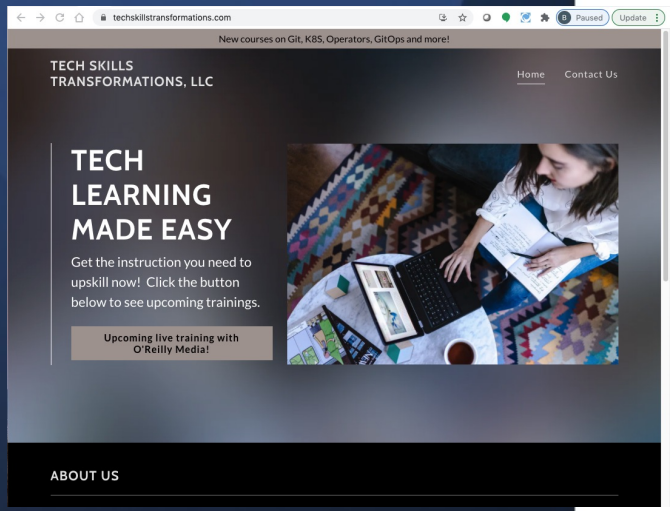
About me



- Founder, Tech Skills Transformations LLC
- R&D DevOps Director
- Global trainer – training (Git, Jenkins, Gradle, CI/CD, pipelines, Kubernetes, Helm, ArgoCD, operators)
- Author -
  - OpenSource.com
  - Professional Git book
  - Jenkins 2 – Up and Running book
  - Continuous Integration vs. Continuous Delivery vs. Continuous Deployment mini-book on Safari
- https://www.linkedin.com/in/brentlaster
- @BrentCLaster
- GitHub: brentlaster

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Professional Git Book

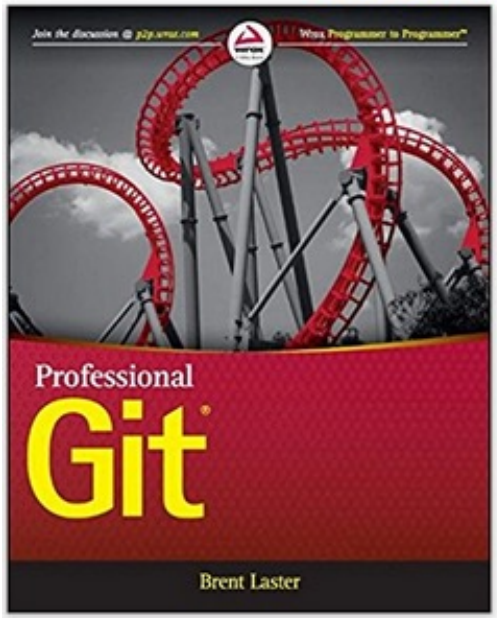
- Extensive Git reference, explanations,
- and examples
- First part for non-technical
- Beginner and advanced reference
- Hands-on labs

Professional Git 1st Edition

by Brent Laster (Author)

7 customer reviews

Look inside



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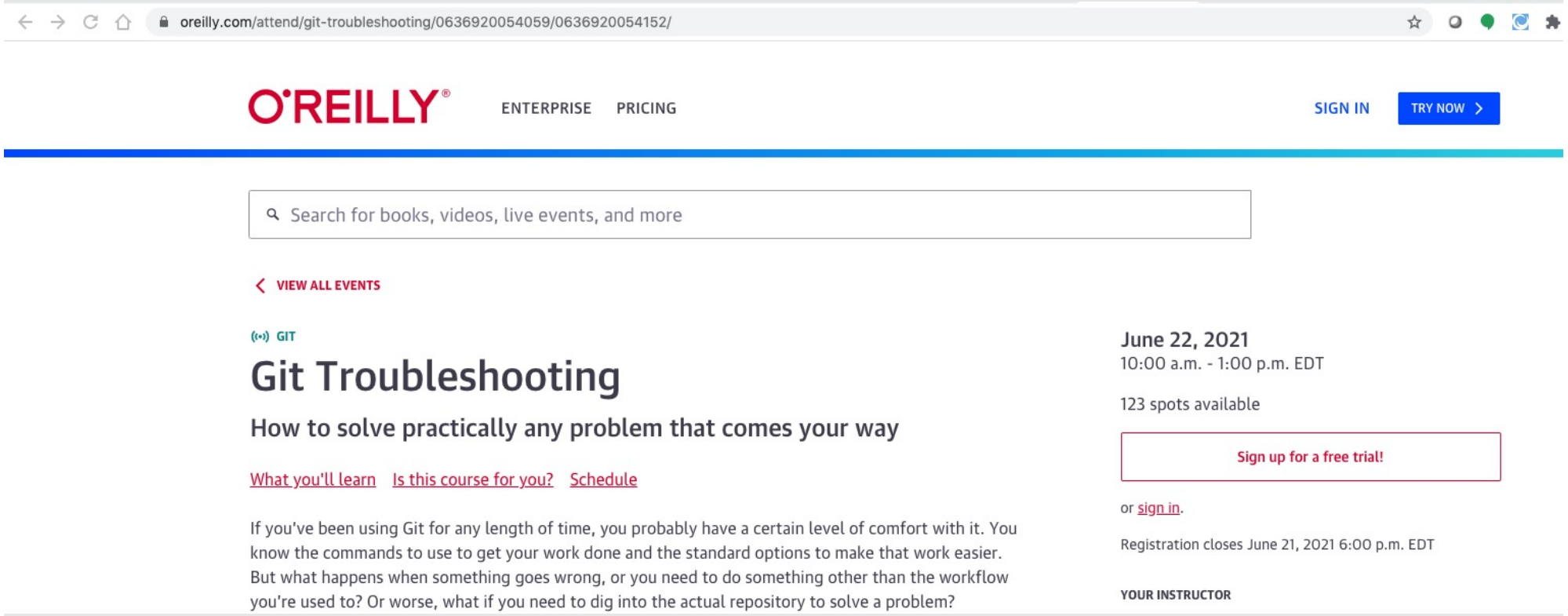
O'Reilly Training



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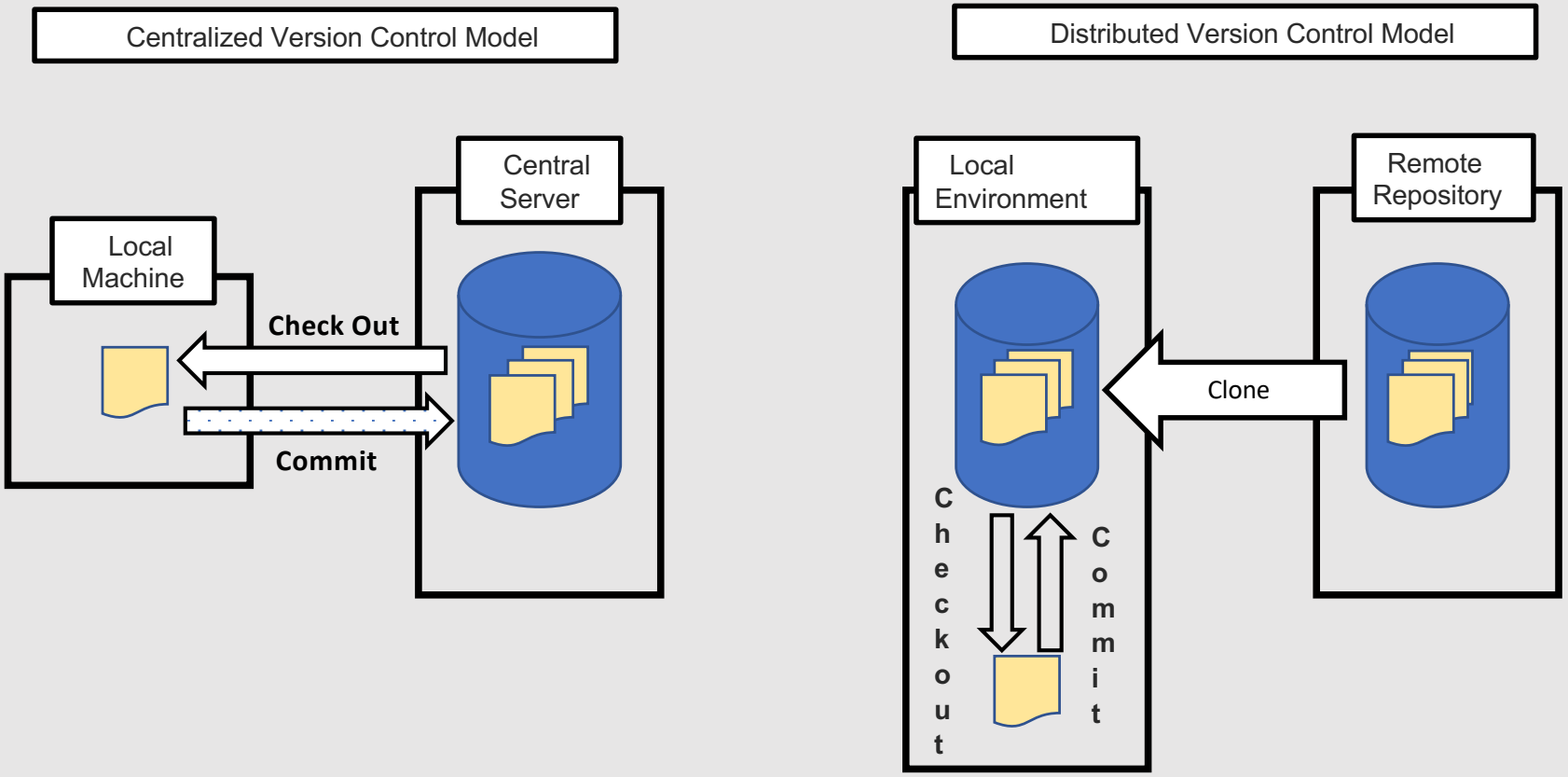
Review

Centralized vs. Distributed VCS



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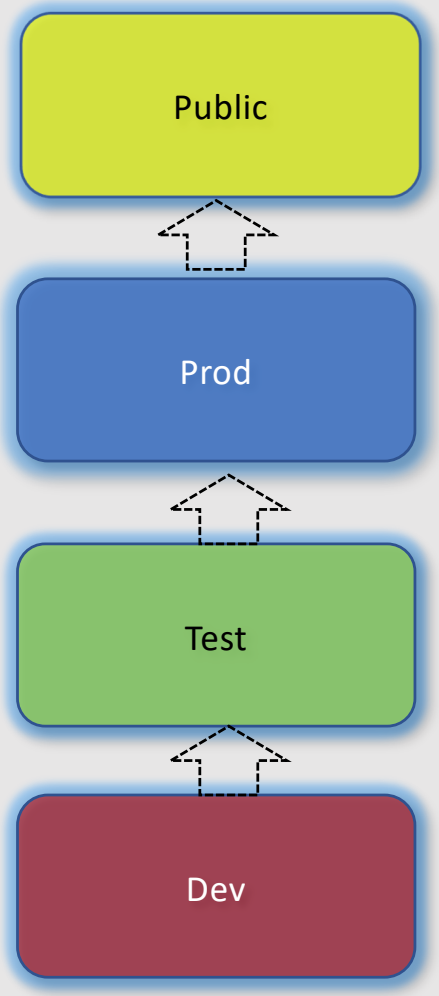
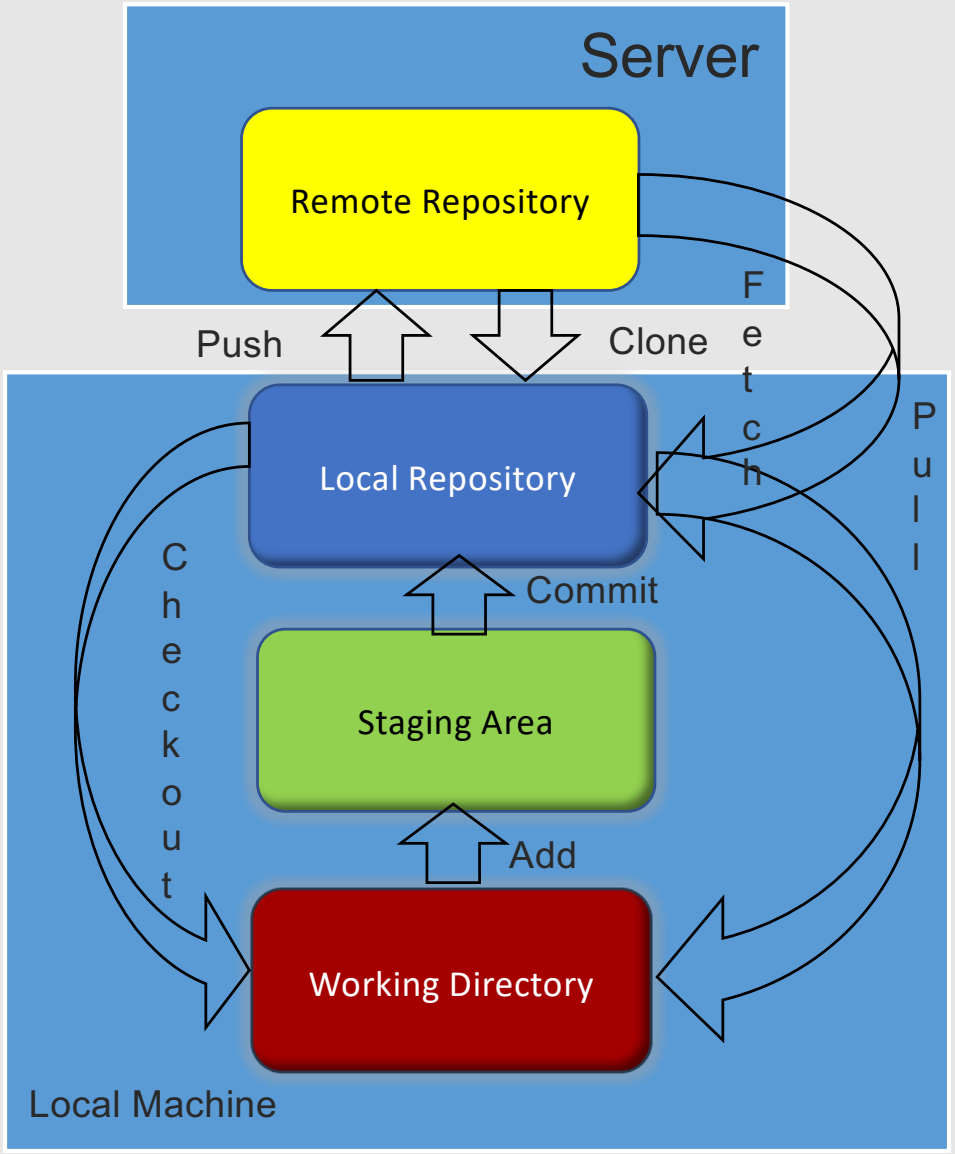
Git in One Picture





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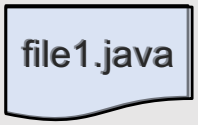
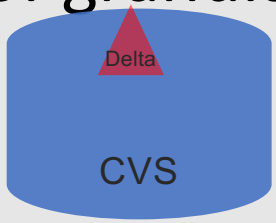
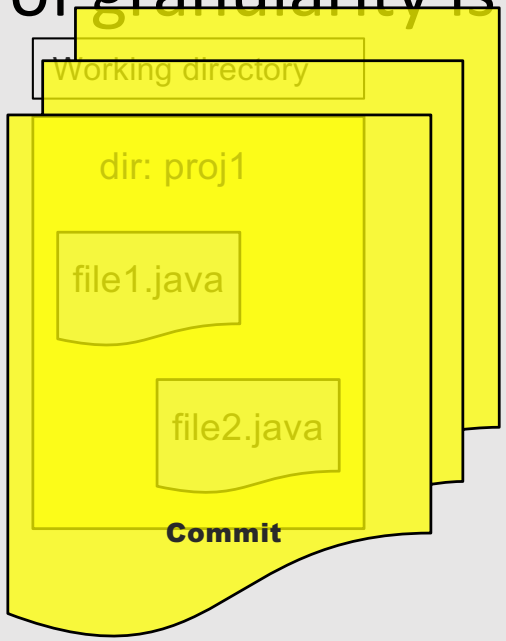
Git Granularity (What is a unit?)

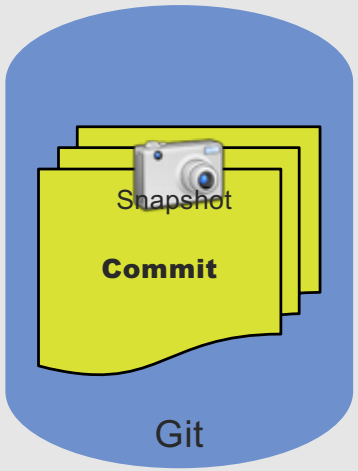
- In traditional source control, the unit of granularity is usually a file





- In Git, the unit of granularity is usually a tree





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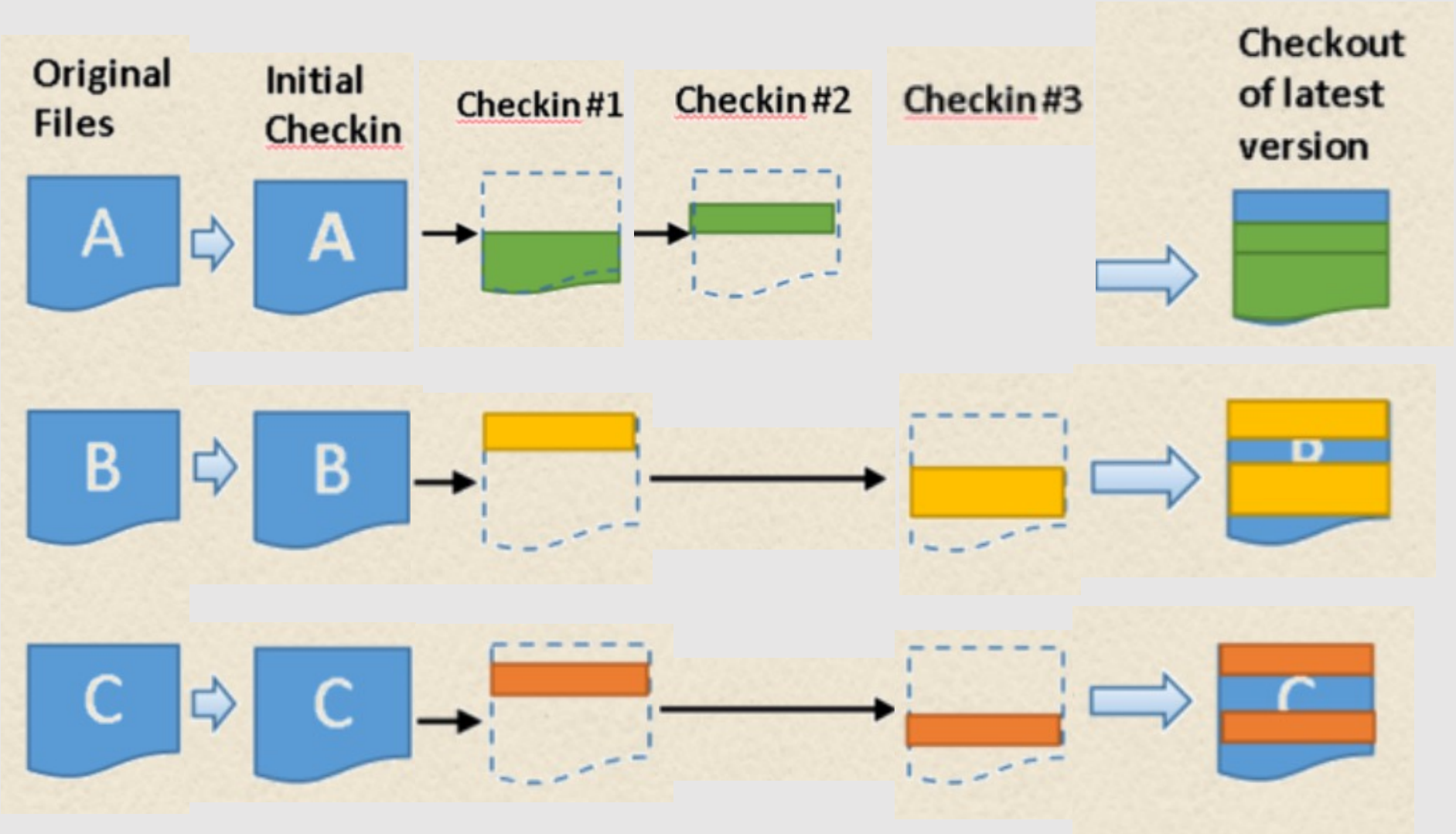
Delta Storage Model



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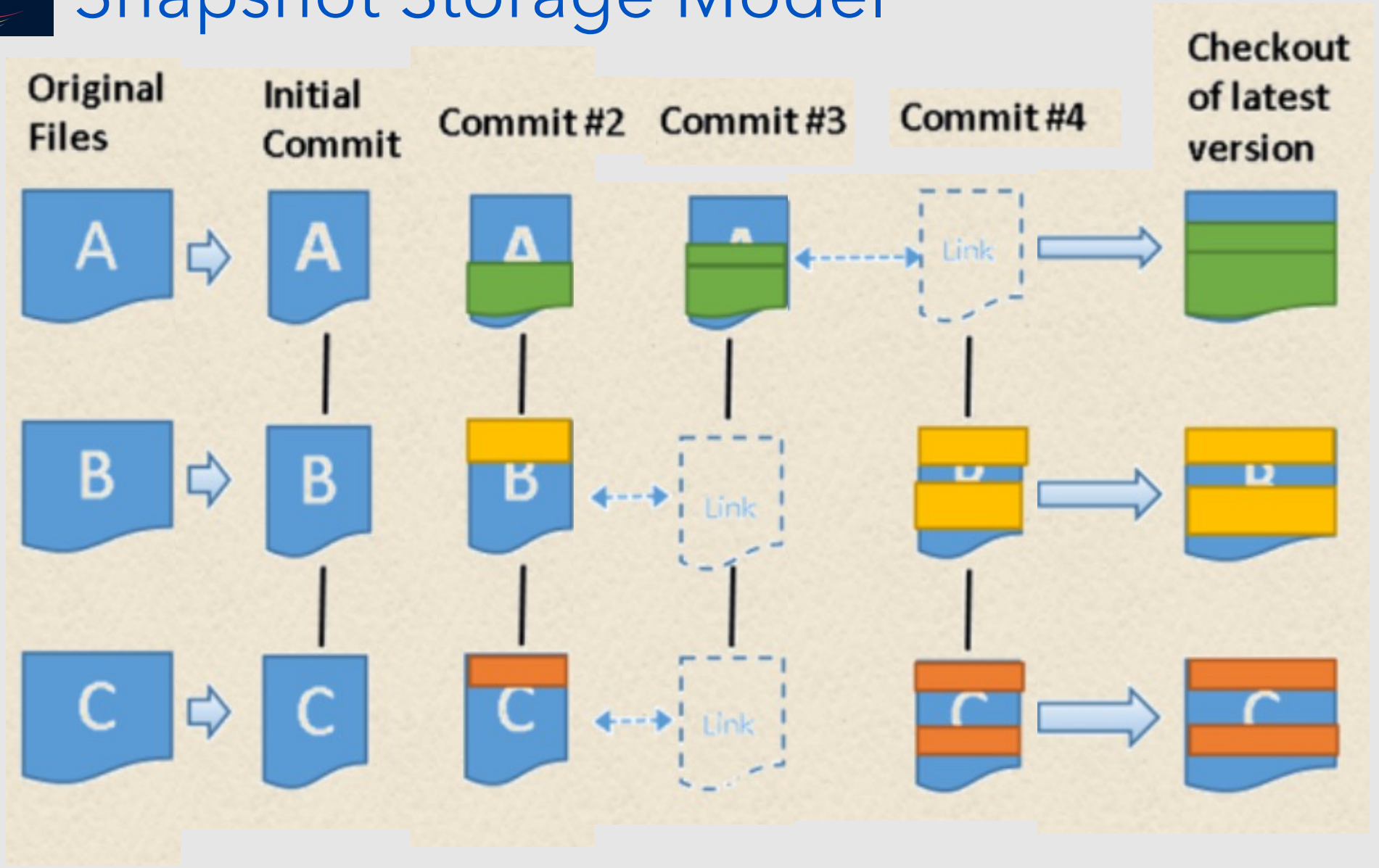
Snapshot Storage Model



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Initializing a Repo and Adding Files (commands)

- git init
  - For creating a repository in a directory with existing files
  - Creates repository skeleton in .git directory
- git add
  - Tells git to start tracking files
  - Patterns: git add *.c or git add . (. = files and dirs recursively)
- git commit
  - Promotes files into the local repository
  - Uses –m to supply a comment
  - Commits everything unless told otherwise


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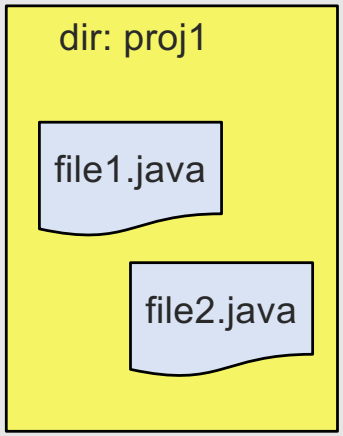
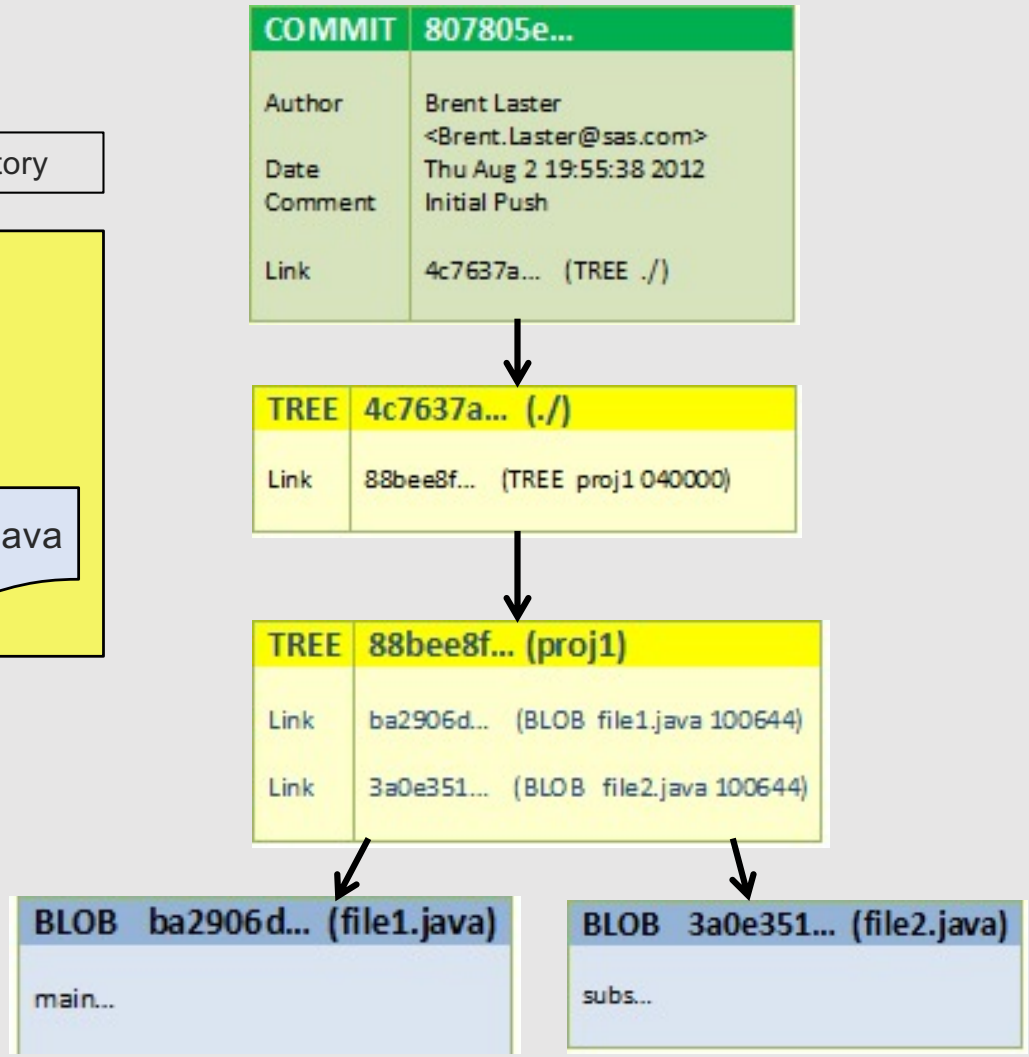
Git and File/Directory Layouts

Working directory



Git snapshot



Local Repository File Layout

```
$ tree.sh -* .git
COMMIT_EDITMSG
HEAD
config
description
hooks
        applypatch-msg.sample
        commit-msg.sample
        post-commit.sample
        post-receive.sample
        post-update.sample
        pre-applypatch.sample
        pre-commit.sample
        pre-rebase.sample
        prepare-commit-msg.sample
        update.sample
index
info
        exclude
logs
        HEAD
        refs
                heads
                        master
objects
        3a
                0e351dc84e32abec5d4dd223c5abdabd57b7f5
        4c
                7637a4b66aefc1ee877eaa1afc70610f0ee7cc
        80
                7805ea7ae9fdf1b06e876af6e9a69a349b52a3
        88
                bee8f0c181784d605eabe35fb04a5a443ae6b7
        ba
                2906d0666cf726c7eaadd2cd3db615dedfdf3a
        info
                *
        pack
                *
refs
        heads
                master
        tags
                *
```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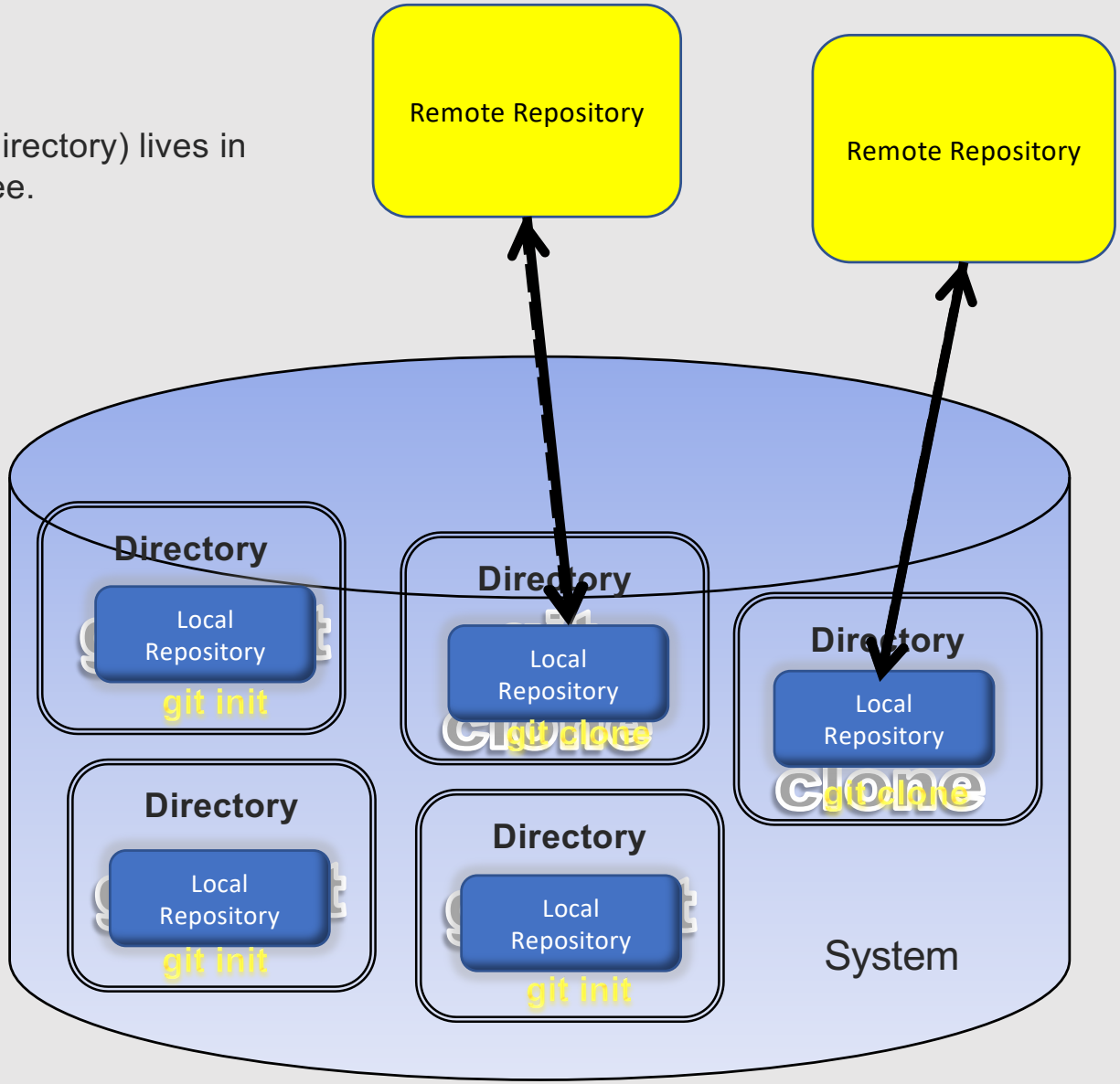
Starting Work with Git – Multiple Repositories

The repository (.git directory) lives in the local directory tree.



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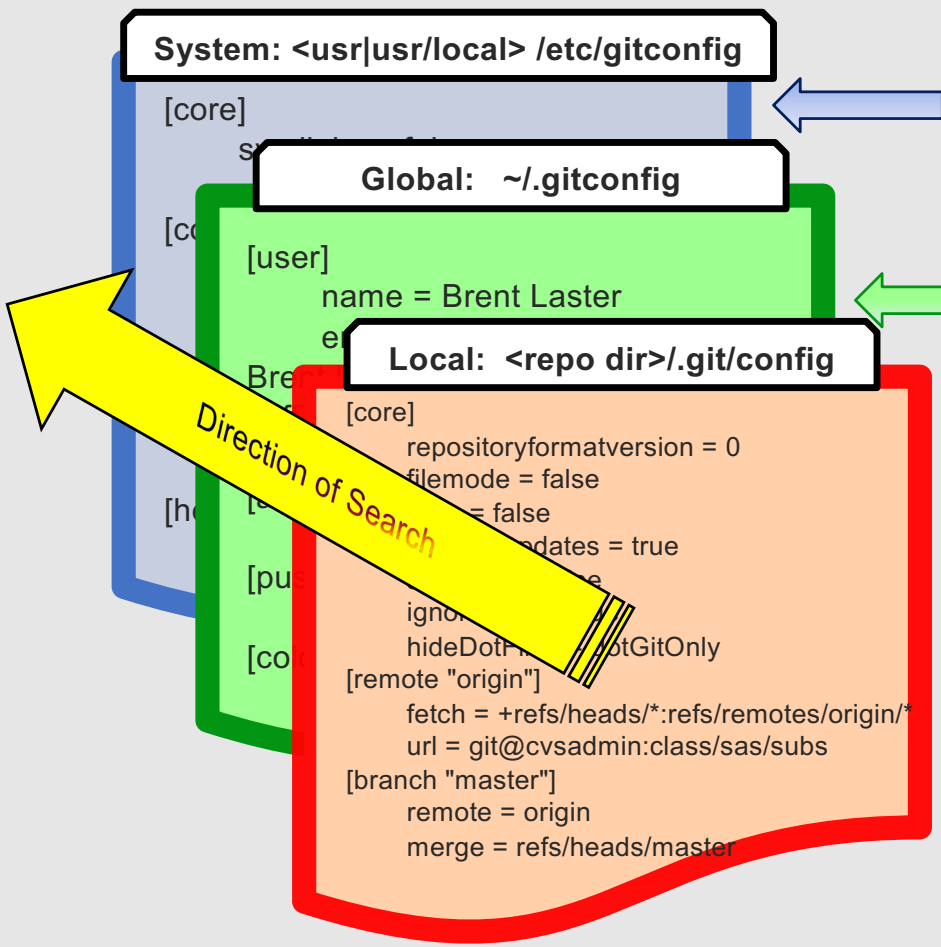
Git Configuration Files



System Configuration File (if exists)
Scope: All users on system

`git config --system`

Global Configuration File
Scope: Current User

`git config --global`

Local Configuration File
Scope: Local repository

`git config or git config --local`

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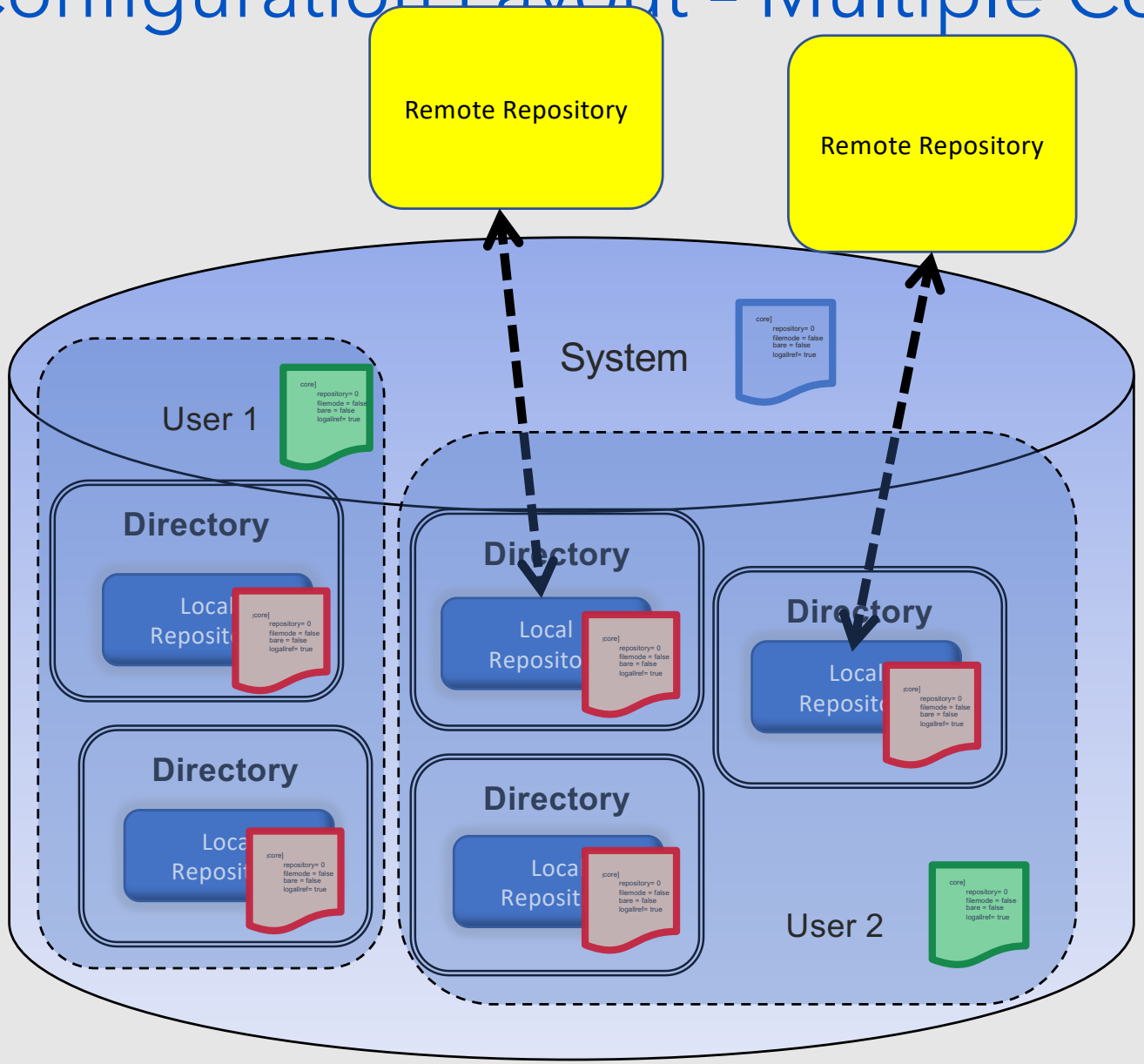
Git Configuration Layout – Multiple Configs



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How Git reports status on files

Files in your working directory can be in one of two main states:

- ***Tracked***
  - Were in the last snapshot (last commit)
  - Can be
    - Unmodified - same as what's in Git
    - Modified - different from what's in Git
    - Staged

  - OR -
- ***Untracked***
  - Everything else
  - Not in last snapshot
  - Not in staging area

3 questions to think about for determining status

- Is Git aware of the file (is it in Git)? tracked or untracked
- What is in the staging area?
- What is the relationship of the latest version in Git to the version in the working directory?

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Showing Differences

- Command : git diff
- Default is to show changes in the working directory that are not yet staged.
- If something is staged, shows diff between working directory and staging area.
- Option of --cached or --staged shows difference between staging area and last commit (HEAD)
- git diff <reference> shows differences between working directory and what <reference> points to – example “git diff HEAD”

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Git log examples

- git log --pretty=oneline --max-count=2
- git log --pretty=oneline --since='5 minutes ago'
- git log --pretty=oneline --until='5 minutes ago'
- git log --pretty=oneline --author=<your name>
- git log --pretty=oneline --all
- git log --oneline --decorate


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Git Aliases

- Allow you to assign alternatives for command and option strings
- Can set using
  - git config alias.<name> <operation>
- Example
  - git config --global alias.co checkout
  - After, “git co” = “git checkout”
- Example aliases (as they would appear inside config file)

```
[alias]
    co = checkout
    ci = commit
    st = status
    br = branch
    hist = log --pretty=format:\"%h %ad | %s%d [%an]\" --graph --
    date=short
```


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Tags in Git

- Command: git tag
- Two types
  - Lightweight – like regular tag, pointer to specific commit
  - Annotated – stored as full object in the database
    - » Checksummed
    - » Contain full email and date, tagger name, and comment
    - » Created by git tag –a <tag> -m <message>
- Create a tag
  - Git tag <tagname> <hash>
- Show tags
  - Git tag (lists tags out)
  - Git show <tag> - shows detail

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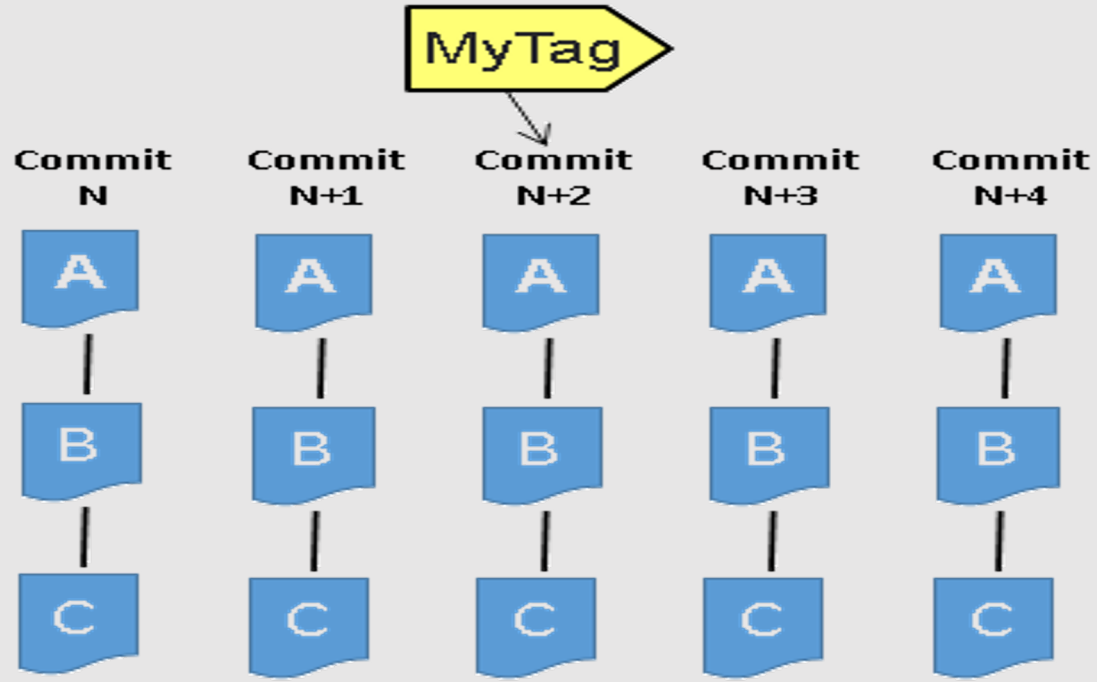
Notes about Tags

- You tag commits (hashes), not files
- A tag is a reference (pointer) to a commit that stays with that commit
- To reference a file via a tag, you need to qualify with the file name (since the tag refers to entire commit)



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New Content

Supporting Files - .gitignore

- Tells git to not track files or directories (normally listed in a file named .gitignore)
- Operations such as git add . will skip files listed in .gitignore
- Rules
  - Blank lines or lines starting with # are ignored.
  - Standard glob patterns work.
  - You can end patterns with a forward slash (/) to specify a directory.
  - You can negate a pattern by starting it with an exclamation point (!).
- What types of things might we want git to ignore?


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Supporting Files - .gitattributes

- A git attributes file is a simple text file that gives attributes to pathname – meaning git applies some special setting to a path or file type.
- Attributes are set/stored either in a .gitattributes file in one of your directories (normally the root of your project) or in the .git/info/attributes file if you don't want the attributes file committed with your project.
- Example use: dealing with binary files
- To tell git to treat all obj files as binary data, add the following line to your .gitattributes file:
- *.obj binary
  - With this setup, git won't try to convert or fix eol issues. It also won't try to compute or print a diff for changes in this file when you run git show or git diff on your project.


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Git Attributes File – Example

- Basic example

```
# Set default behaviour, in case users don't have core.autocrlf set.
* text=auto

# Explicitly declare text files we want to always be normalized and converted
# to native line endings on checkout.
*.c text
*.h text

# Declare files that will always have CRLF line endings on checkout.
*.sln text eol=crlf

# Denote all files that are truly binary and should not be modified.
*.png binary
*.jpg binary
```

- Advantage is that this can be put with your project in git. Then, the end of line configuration now travels with your repository. You don't need to worry about whether or not all users have the proper line ending configuration.
- Some sample gitattributes files in GitHub for certain set of languages.

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Removing files

- Command: git rm
- What it does:
  - Removes it from your working directory (via rm <file>) so it doesn't show up in tracked files
  - Stages removal
- Then you do the commit to complete the operation
- If you have a staged version AND a different modified version, git will warn you
  - Use the –f option to force the removal
- Can remove just from the staging area using --cached option on git rm
- Can provide files, directories, or file globs to command


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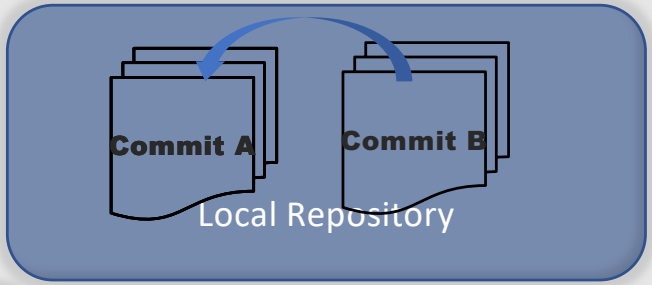
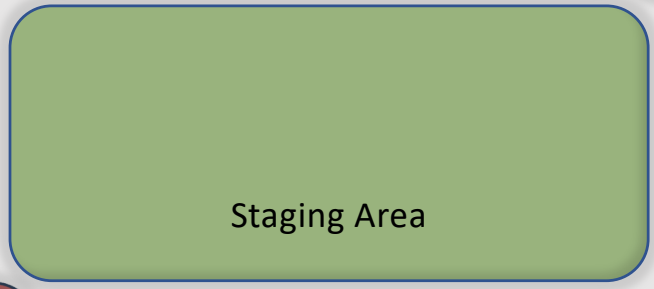
Git Workflow for operations like rm

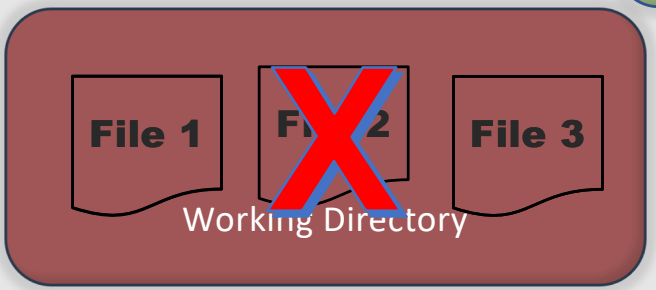
1. Git performs the operation in the working directory
2. Git stages the change
3. User commits to finalize the operation in the repository.

git rm file2

git commit -m "finalize rm"







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Rolling back/undoing - Reset and Revert

- Reset -- allows you to “roll back” so that your branch points at a previous commit ; optionally also update working directory to that commit
- Use case - you want to update your local environment back to a previous point in time; you want to overwrite or a local change you’ve made
- Warning: --hard overwrites everything
- Revert -- allow you to “undo” by adding a new change that cancels out effects of previous one
- Use case - you want to cancel out a previous change but not roll things back
- Note: The net result of using reset vs. revert can be the same. If so, and content that is being reset/revert has been pushed such that others may be consuming it, preference is for revert.

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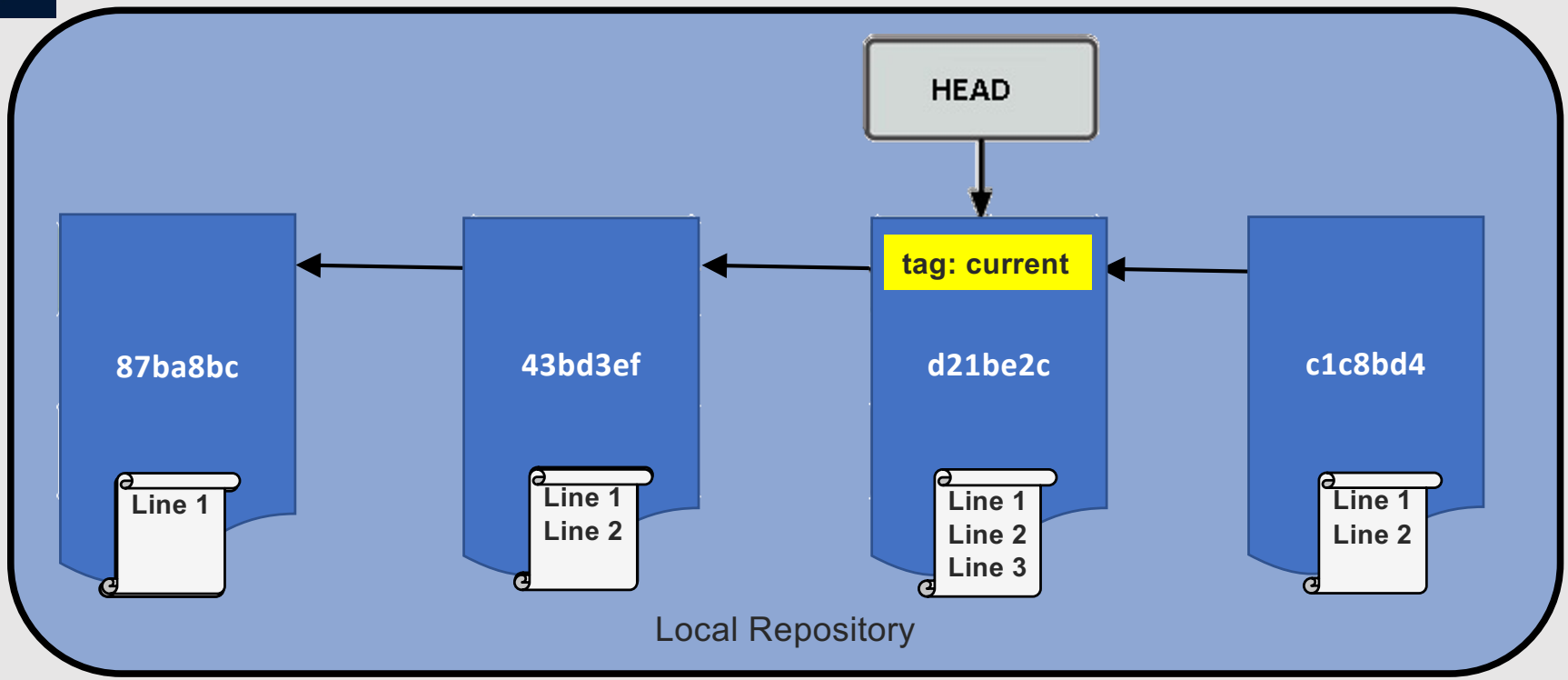
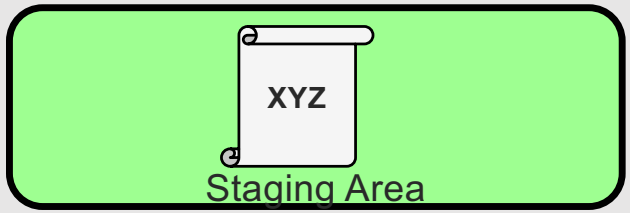
Reset and Revert

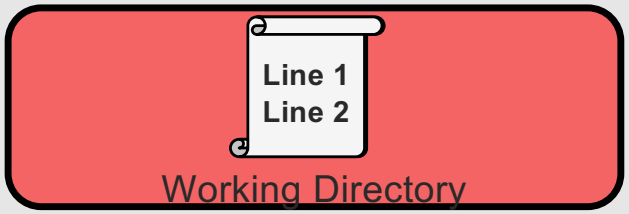


git reset --hard 87ba8bc

git reset current~1 [--mixed]

git revert HEAD





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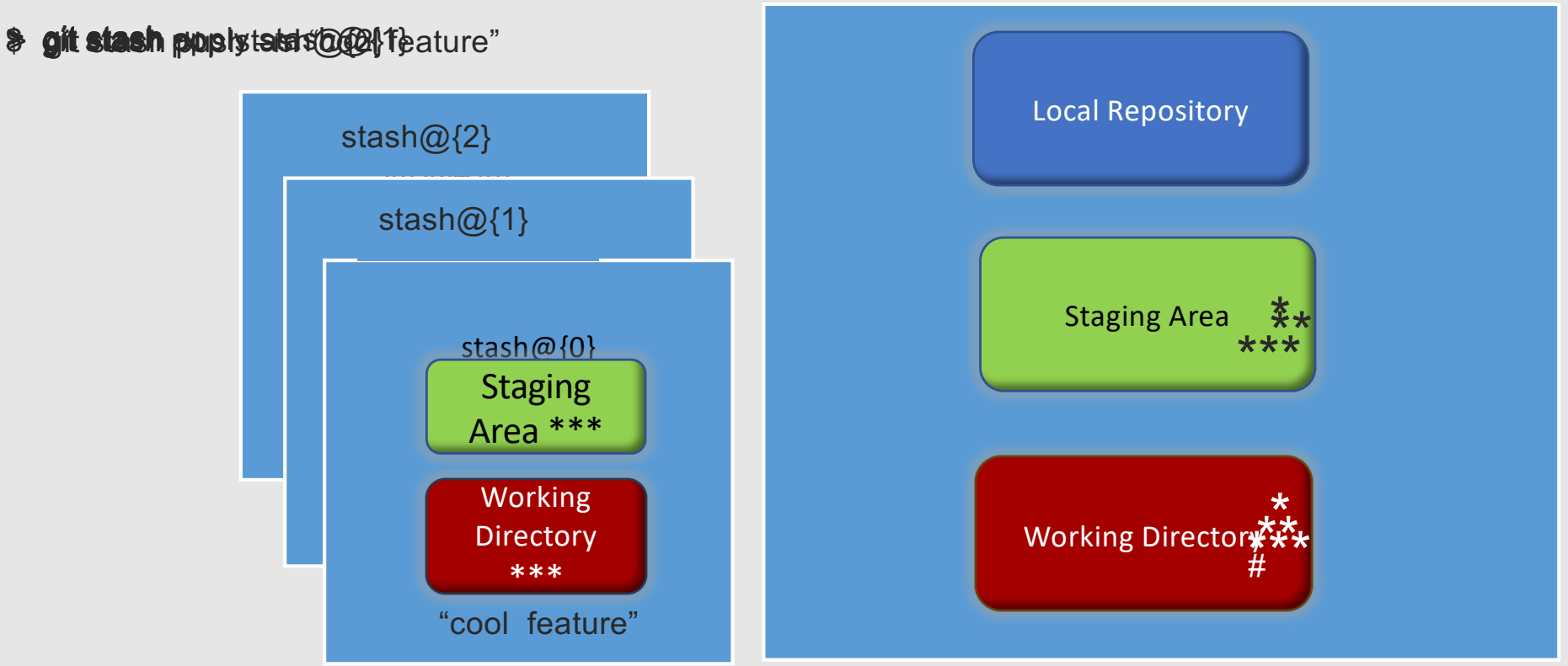
Git Stash

- **Keep a backup queue of your work**
  - **command: git stash [push]**
  - **saves off state**
  - **use git stash pop or git stash apply to get old state back**



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Renaming Files

- Git doesn't track metadata about renames, but infers it
- Git mv command renames a file locally and stages the change
- Then you commit it
- Git will show "renamed" in status after a mv
- The mv command is equivalent to:
  - mv (old local file) (new local file)
  - git rm old file
  - git add new file


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What is a branch in source control?

- Line of development
- Collection of specific versions of a group of files tagged in a common way
  - cvs rtag -a -D <date/time> -r DERIVED_FROM -b NEW_BRANCH PATHS_TO_BRANCH
- End result is I have an easy “handle” to get all of the files in the repository associated with that identifier – the branch name
  - cvs co –r BRANCH_NAME PATHS
- So – what you end up with in your working directory when you check out a branch is a set of specific versions of the files from the group, or a …

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Snapshot! What is a snapshot (in GIT)?

- Line of development associated with a specific change
- Collection of specific versions of a group of files associated with a specific commit
- End result is I have a “handle” to get all of the versions of files in the repository associated with that commit – handle = SHA1 for that commit
- What you end up with in your working directory when you check out a branch is a set of specific versions of the files from the group.

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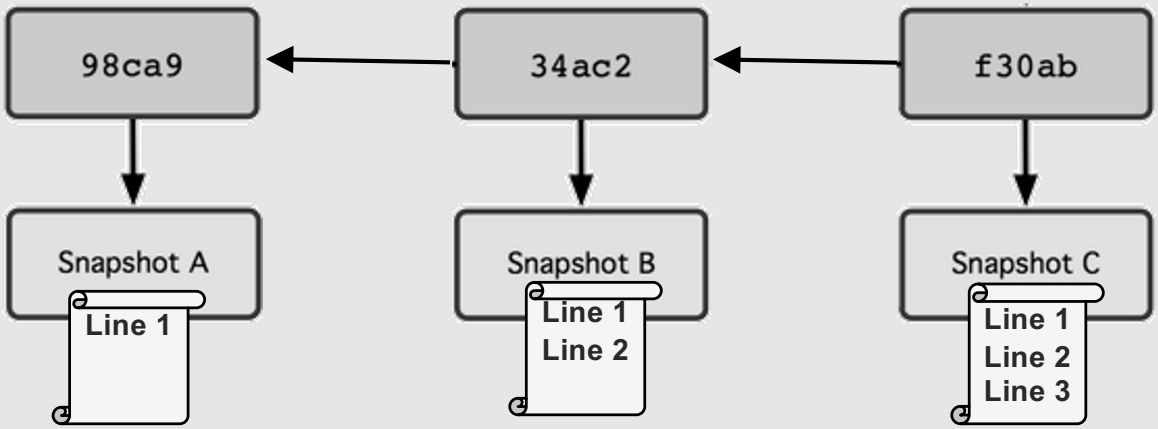
Branches

- Remember, git stores data as a series of snapshots, not deltas or changesets
- Commits point to snapshots – and the commit that came before them



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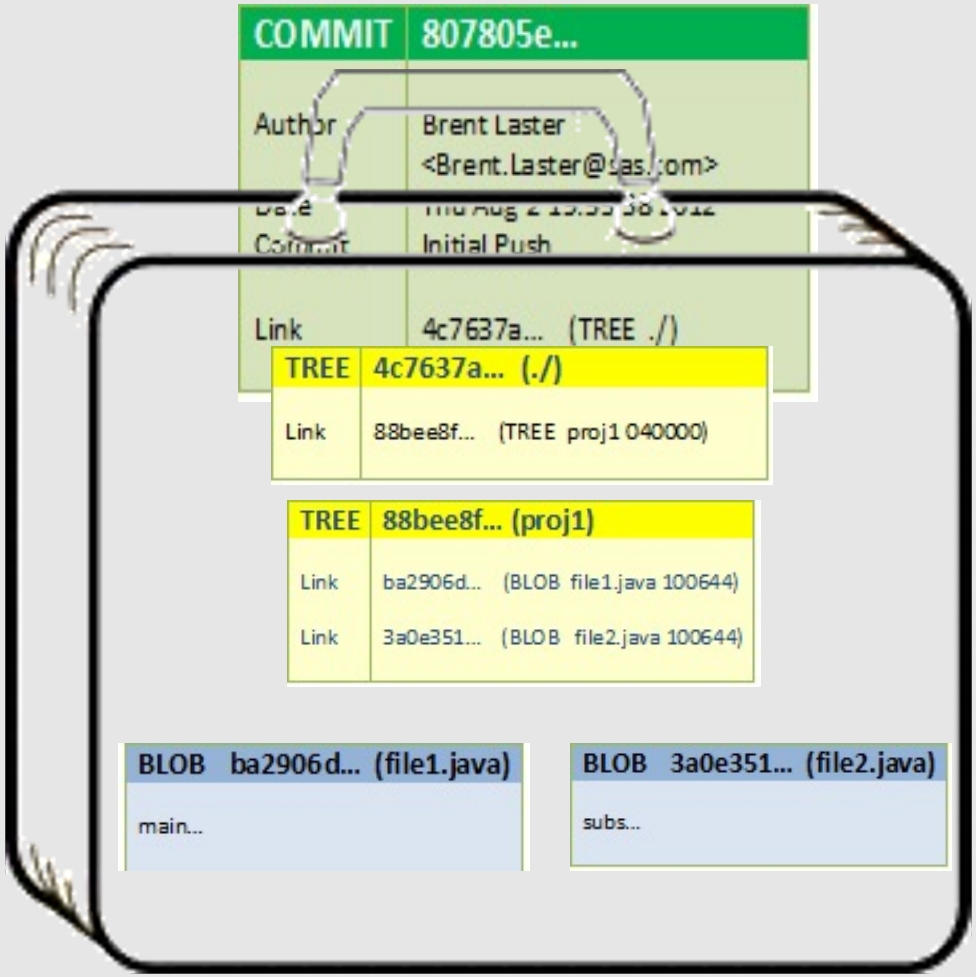
Commit SHA1's are a handle to a snapshot



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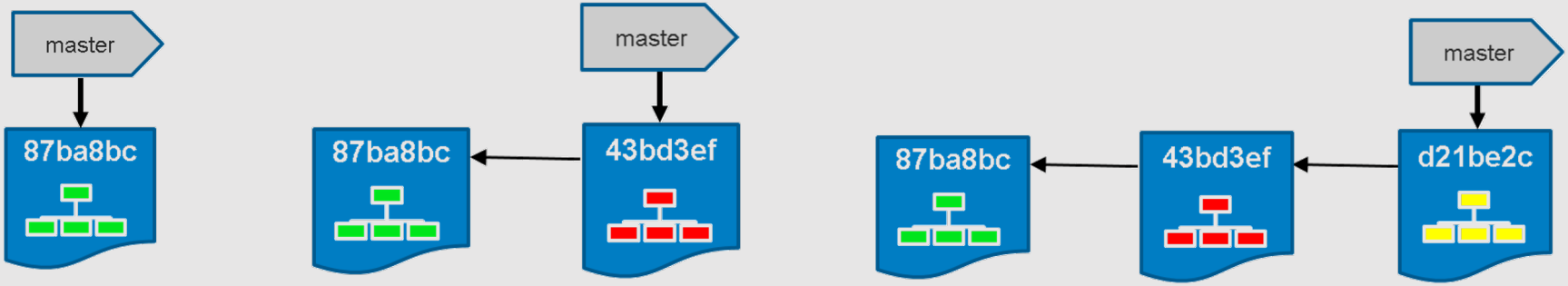
Lightweight Branching

- A branch in git is simply a lightweight, movable pointer to a commit
- Default branch is named master
- As you initially make commits, you're given a branch pointer that points to the last commit you made. Every time you commit, it moves forward automatically.



- A branch in Git is just a simple file that contains the 40 character SHA-1 checksum of the commit it points to, branches are cheap to create and destroy. Creating a new branch is as quick and easy as writing 41 bytes to a file (40 characters and a newline).

- And, because we're recording the parents when we commit, finding a proper merge base for merging is automatically done for us and is generally very easy to do.

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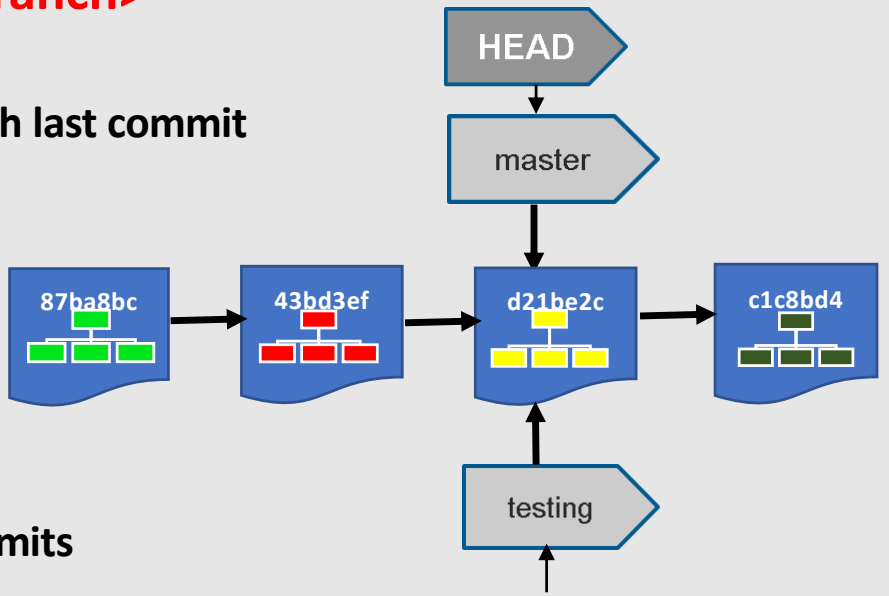
Creating and using a new branch

- Create a branch : git branch <branch>
  - Creating a new branch creates a new pointer

Git keeps a special pointer called HEAD that always points to the current branch.

git branch testing

- Change to a branch: git checkout <branch>
  - Moves HEAD to point to <branch>
  - Updates working directory contents with last commit from <branch> - if existing branch



git checkout testing

- Branch pointers advance with new commits

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Switching between Branches

Command: git checkout <branch>

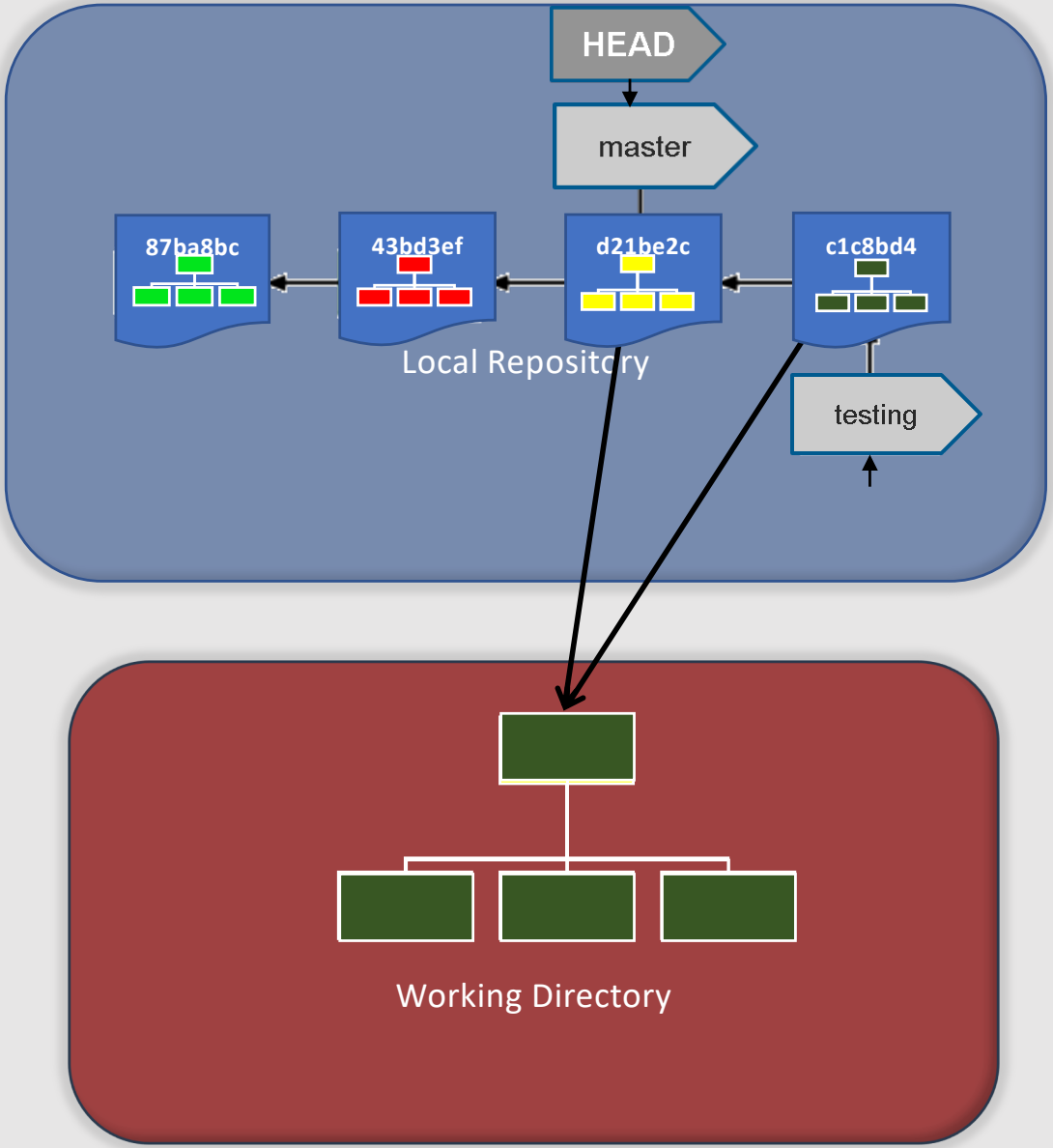
git checkout master

- **Does three things**
  - **Moves HEAD pointer back to <branch>**
  - **Reverts files in working directory to snapshot pointed to by <branch>**
  - **Updates indicators**

git checkout testing

git checkout master

git checkout testing



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Which Branch am I on/in?

- Command: git branch <no arguments>
- "*" is indicator of which one you're on
- Prompt will also change in some configurations
  - If it doesn't, can be setup.


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"Topic and Feature Branches"

- Topic Branches
  - Term for a temporary branch to try something out
  - Easy to try things in or come back to later
  - Generally, create simple name based on type of work you're going to try – i.e. web_client
  - Maintainer of a project may "namespace" these – as in adding initials on the front – i.e. abc/web_client
  - Create just as any other branch

    ```
    $ git branch abc/web_client
    $ git checkout –b web_client
    ```

- Feature Branches
  - Term for a branch to develop a feature
  - Intended for limited lifetime
  - Merge back into main line of development

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Lab 4 - Working with Branches

Purpose: In this lab, we'll start working with branches by creating a new branch and making changes on it.

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Merging Branches

- Command: git merge <branch>
- Relative to current branch
- Current branch is branch being merged into
- <branch> is branch being merged from
- Ensure everything is committed first

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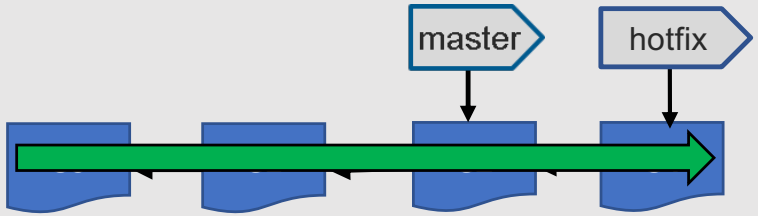
Merging: What is a Fast-forward?

- Assume you have three branches as below
- You want to merge hotfix into master (so master will have your hotfix for future development)

```
$ git checkout master
$ git merge hotfix
Updating f42c576..3a0874c
Fast Forward
README  |  1-
1 files changed, 0 insertions(+) 1 deletions (-)
```



About “Fast Forward” – because commit pointed to by branch merged was directly “upstream” of the current commit, Git moves the pointer forward

(Both branches were in the same line of development, so the net result is that master and hotfix point to the same commit)

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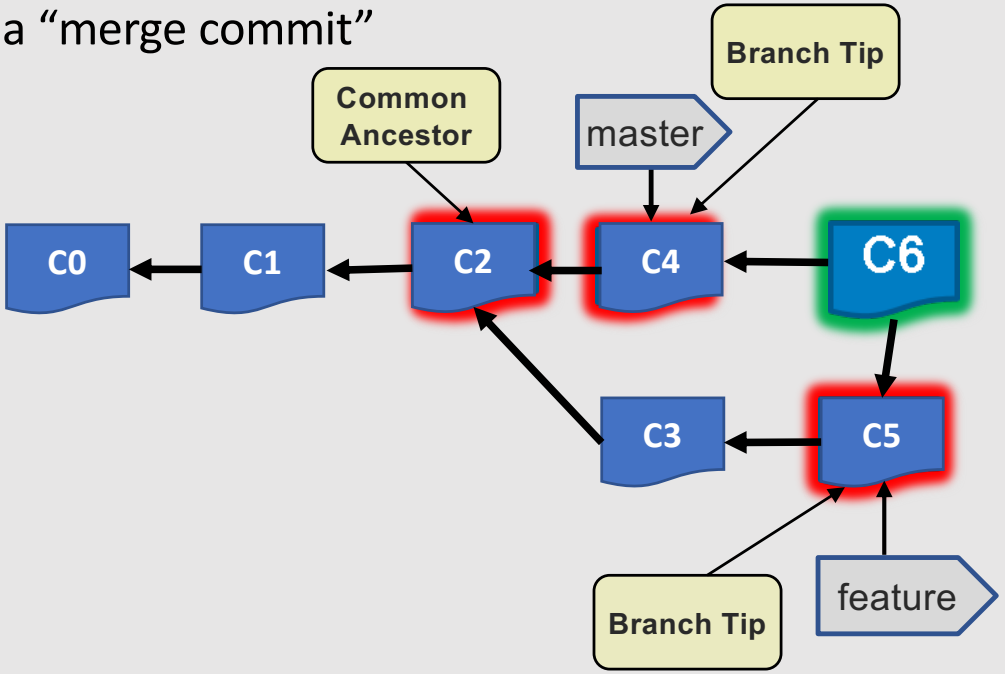
Merging: What is a 3-way Merge?

- Assume branching scenario below
  - master and feature branches have both diverged (changed) since their last common ancestor (commit/snapshot)
- Intent is to change to master and merge in feature
- Current commit on target branch isn't a direct ancestor of current commit on branch you're merging in (i.e. C4 isn't on the same line of development as C5)
- Git does 3-way merge using common ancestor
- Instead of just moving branch pointer forward, Git creates a new snapshot and a new commit that points to it called a "merge commit"




```
$ git checkout master
$ git merge feature
```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Merge Conflicts

- If you encounter a merge conflict during a merge operation
  - Will get CONFLICT message
  - Git pauses merge in place
  - To see which files are unmerged, use git status – will see "unmerged: or both modified: <filename>"
  - Adds <<<<< and >>> markers in the file
- After resolution, run git add and then commit
- Can also run git mergetool to resolve graphically

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Merge Scenario – Branches with Conflicts

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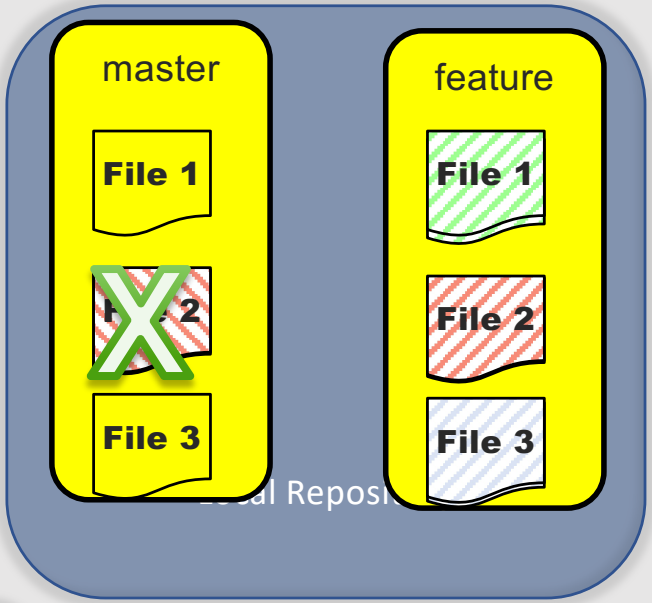
```
$ git checkout master
$ git merge feature
$ git status
      Changes to be committed:
            modified: File 1
            modified: File 3
      Unmerged paths
            both modified: File 2
 [fix conflicts]
$ git add .
$ git commit –m
 “finalize merge”
```



Staging Area

Working Directory

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Lab 5 - Practice with Merging

Purpose: In this lab, we'll work through some simple branch merging

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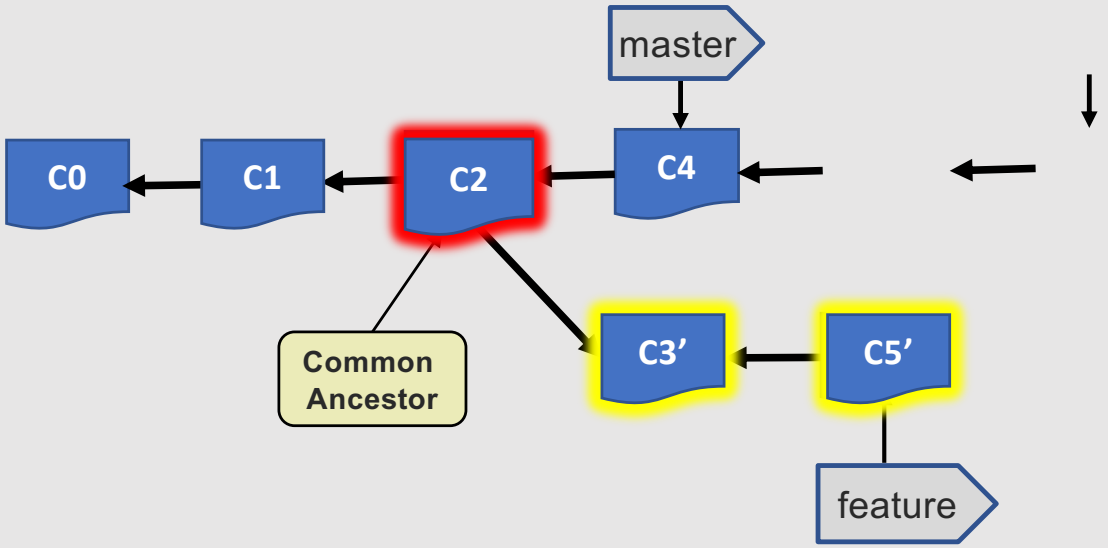
Merging: What is a Rebase?

- Rebase – take all of the changes that were committed on one branch and replay (merge) them (one at a time in sequence) on another one.
- Process:
  - Goes to the common ancestor of the two branches (the one you are on and the one you are rebasing onto)
  - Gets the diff introduced by each commit of the branch you are on, saving them to temporary files
  - Applies each change in turn
  - Moves the branch to the new rebase point

```
$ git checkout feature
$ git rebase master
```



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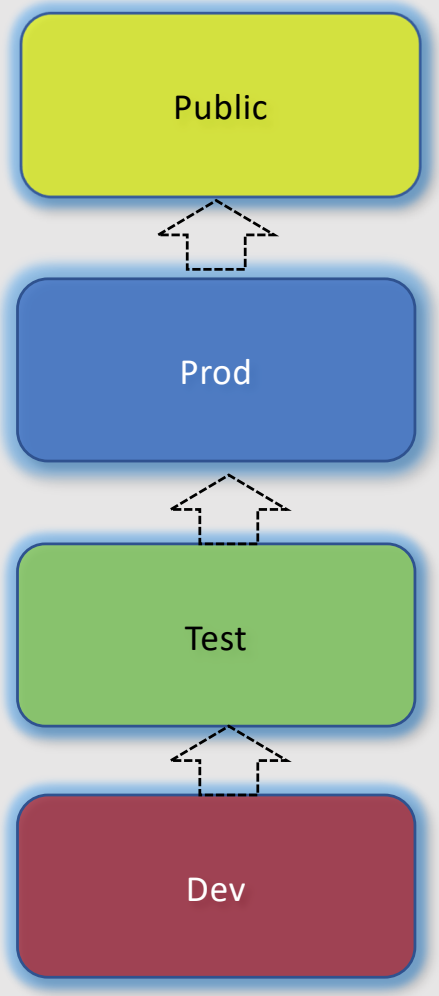
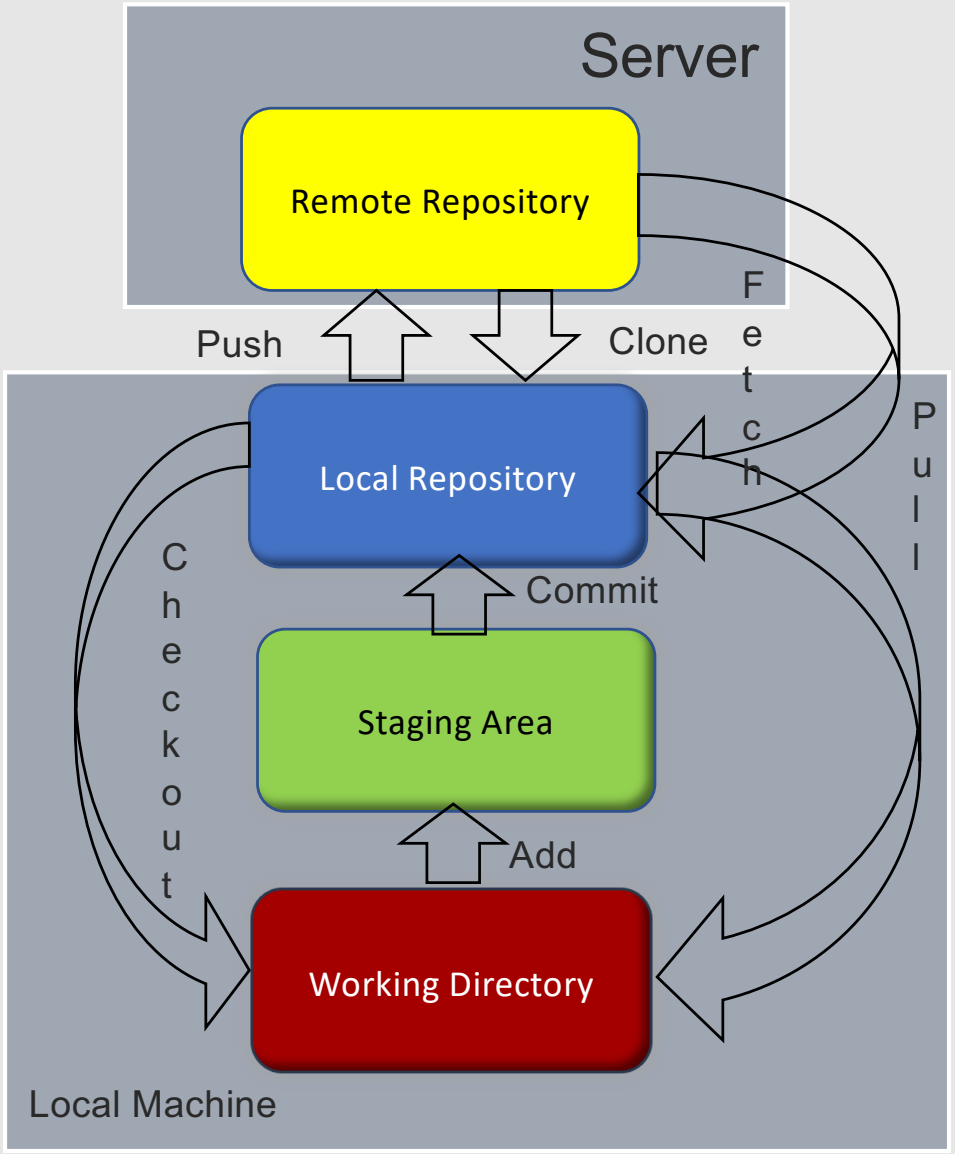
Git in One Picture





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Cloning a Remote Repo to get a Local Repo

- Command: git clone
  - Use to get a copy of an existing repository from a system
  - Syntax: git clone <url> <optional new name>
  - Clone vs. checkout
    - » Git pulls nearly all data from cloned area – files, history, etc.
    - » Creates a directory with the project name
    - » Checks out working copy of latest version
    - » Does a bit more than fetch and pull – tracks local branch to remote branch
  - After cloning, have full access to files, histories, etc.

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Git Remote References "remotes" 53

- The term "remote" can either refer to:
  - An actual remote repository
  - A reference to such a repository
- For local use, Git provides references/aliases/nicknames that map to a remote repository location
- The default one of these is "origin"
- The reference "origin" is automatically setup (mapped) for you when you clone
- Example: origin = https://github.com/<path>
- This mapped name is what you use in local commands to tell git you want to push/pull/fetch/clone to/from the mapped remote repository
- Example: git pull origin <branch>

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Git Remote Repositories

- Remote repositories
  - Think “server-side”
  - Versions of projects hosted on network or internet
  - Push or pull from (as opposed to checkout/add/commit)
  - Generally have read-only or read-write access
  - Handle + url
- Public as opposed to private (local)
- Multiple protocols for data transfer
  - Local – shared folder, easy for collaboration, slow, not for widespread use
  - SSH – standard with authentication, no anonymous access
  - Git – fastest, but no authentication
  - Http - easy, but inefficient
  - Https – easy and authenticated (temporarily)

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Working with Handles to Remotes

- Seeing what you have access to
  - Git remote (short handle by default, -v shows url)
  - “origin” – special name that git gives to remote you cloned from
  - Ssh urls (git@<blah> vs. git protocol git://) and https indicates ones you can push to
  - Git remote show (shortname) – shows extended info about remote
- Adding a remote
  - Think of adding access to existing one
  - Git remote add [shortname (handle)] [url]
    - » Example : git remote add remote2 https://github.com/userid/projectpath
- Renaming shortname
  - Git remote rename <old> <new>
  - Renames remote branches too
- Removing a reference

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Working with Remotes

- Retrieve latest from git remote (getting what you don't have)
  - Git fetch (shortname) as in git fetch brent
  - Note that you are getting the full repository (history, branches, basically everything)
  - Fetch pulls the data to the local repository – it doesn't merge or disturb your local content
- Retrieve latest and merge
  - Git pull
  - By default, git clone automatically sets up to track changes on master branch
  - Pull does a "fetch and merge"
- Pushing back to the server (remote)
  - Git push (shortname) (branch)
  - Only works if you have correct access and remote content hasn't been change
  - If remote content has been changed, then would have to fetch latest and merge (like cvs up-to-date check)

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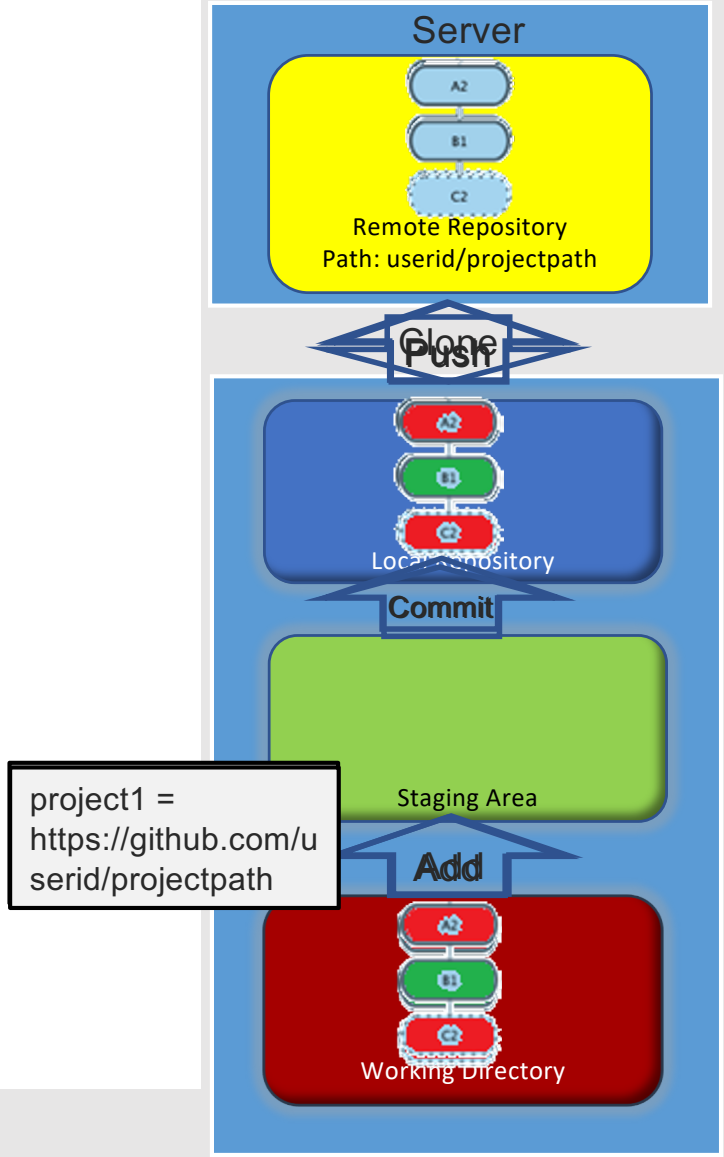
Git Remotes Example

```
$ git clone https://github.com/userid/projectpath
$ git remote -v
origin https://github.com/userid/projectpath(fetch)
origin https://github.com/userid/projectpath (pull)

$ <edit File A and File C>
$ git commit –am "…"
$ git push origin master
  (default is origin and master so could just "git push")

$ git remote rm origin
$ git remote add project1 https://github.com/userid/projectpath
$ git remote -v
project1 https://github.com/userid/projectpath(fetch)
project1 https://github.com/userid/projectpath (pull)

$ <edit File B>
$ git commit –am "…"
$ git push project1
(or git push project1 master)
```



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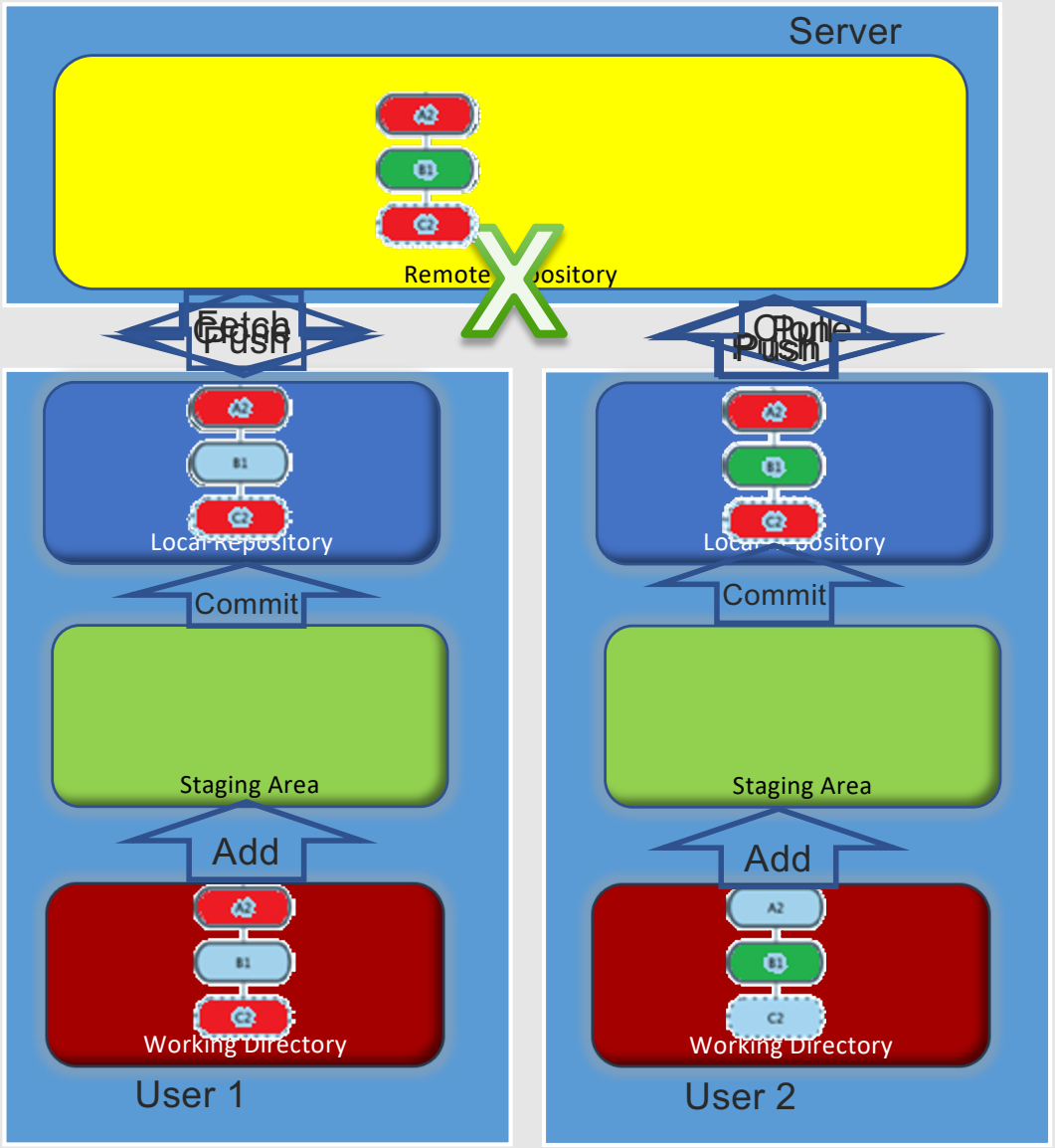
Working with a Remote and Multiple Users

User 1

```
$ git clone …
$ <edit File A and File C>
$ git commit –am “…”
$ git push
$ git fetch
```

User 2

```
$ git clone …
$ <edit File B>
$ git commit –am “…”
$ git push
$ git pull
$ git push
```



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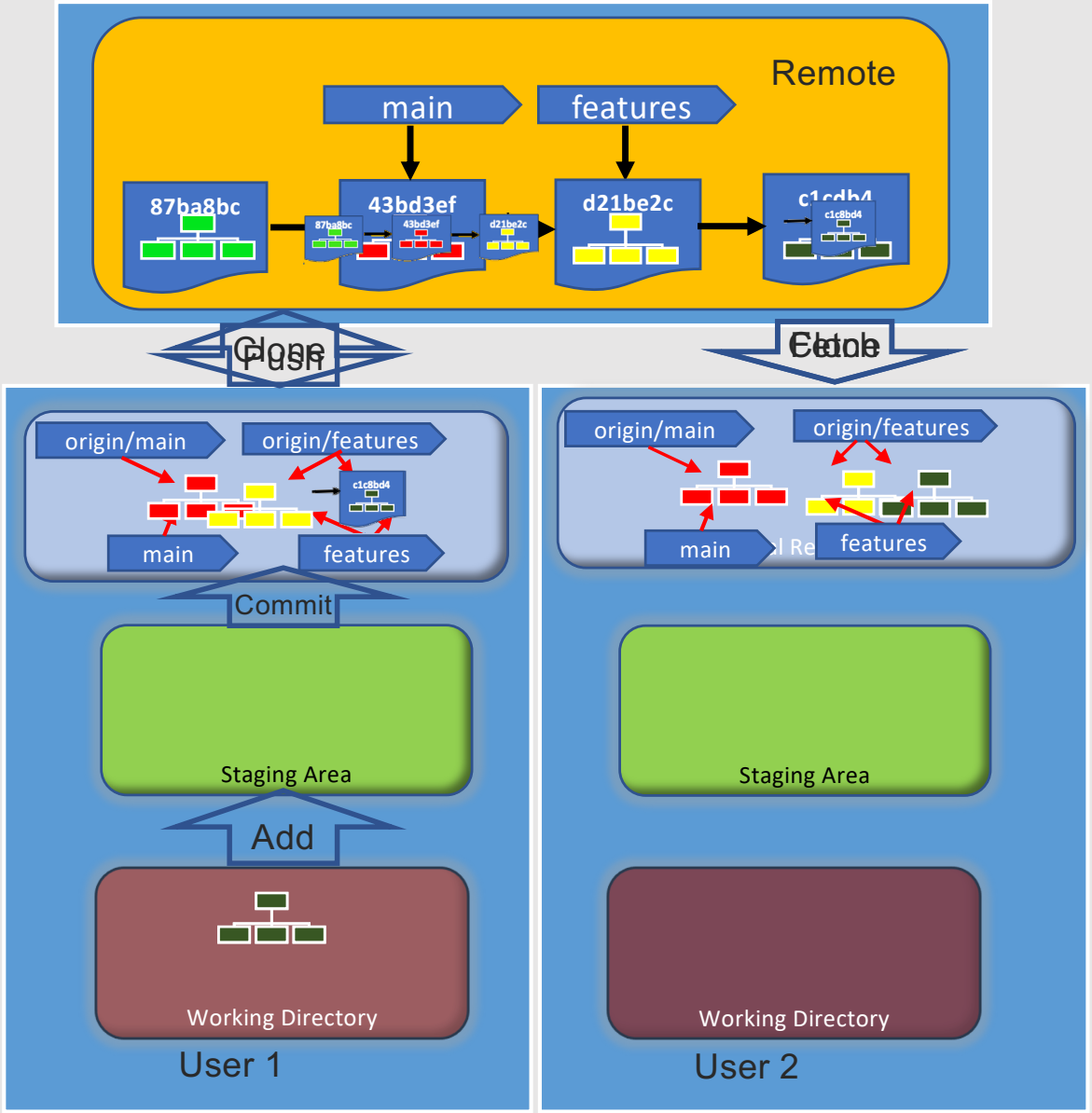
Remote vs Local Branches

User 1

$ git clone …
$ git checkout features
$ git status
On branch features
Your branch is up to date with 'origin/feature'.
<edit file(s)>
$ git commit -am "update"
$ git status
On branch feature
Your branch is ahead of 'origin/feature' by 1 commit.
(use "git push" to publish your local commits)
$ git push

User 2

$ git clone …
$ git checkout features
$ git fetch
$ git status
Your branch is behind 'origin/features' by 1 commit, and can be fast-forwarded.
(use "git pull" to update your local branch)
$ git pull OR $ git merge origin/features



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Lab 6 - Using the Overall Workflow with a Remote Repository

Purpose: In this lab, you'll get some practice with remotes via a GitHub account. You'll fork a repository, clone it down to your system to work with, rebase changes, and deal with conflicts at push time.

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That's all - thanks!

Professional Git 1st Edition

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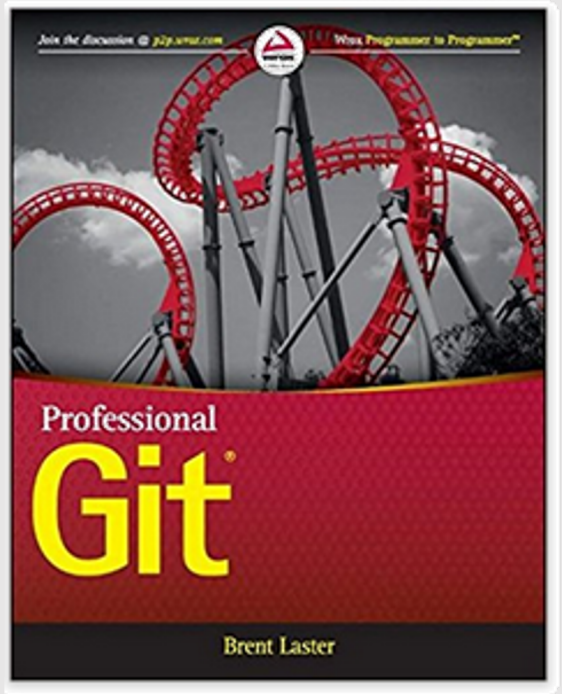
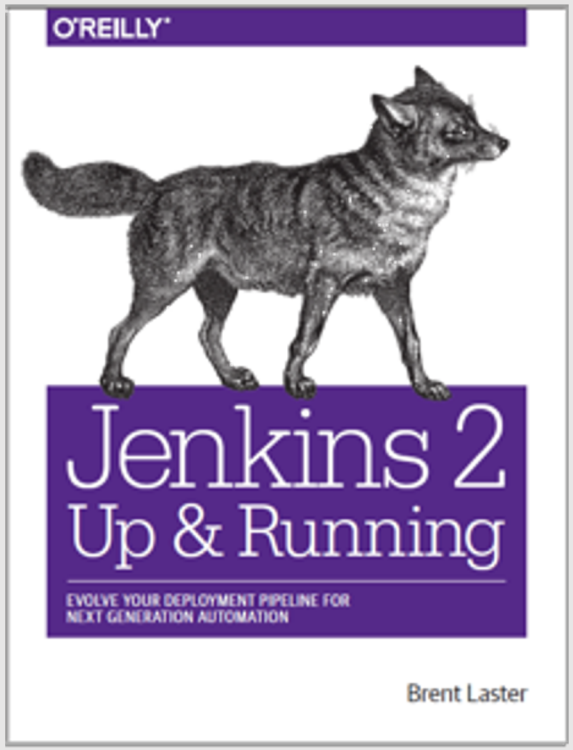
Look inside





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